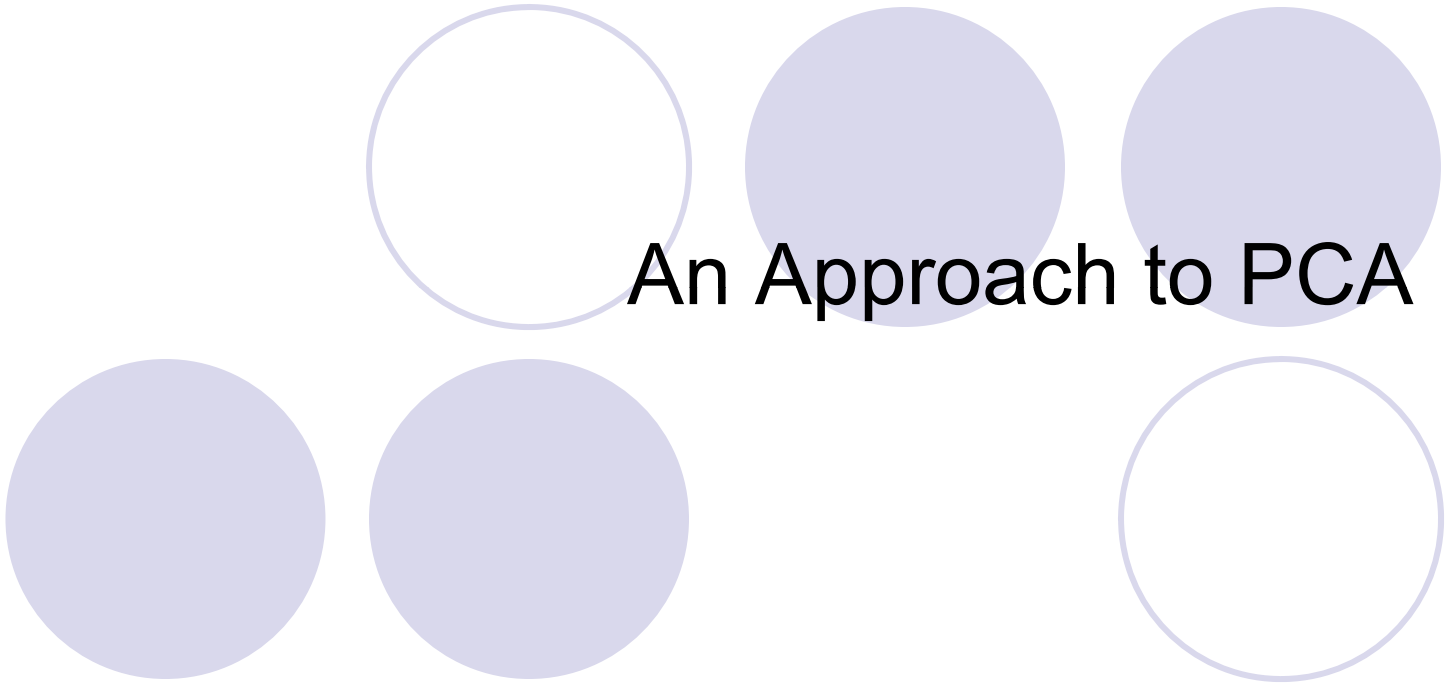


# An Approach to PCA

# Sample Articles on PCA

- 3 articles selected by Prof. M.Sahari Nordin
- - GriefExperience
- - TeacherOrientation
- - NightClubbing Expectancy

# Sample Articles on PCA

## 2 articles from RD's Google Scholar Citations

- Article 15/36 (on 26.1.12) "Restructuring HiT Factors: A Measure of Hybrid e-Training to Overcome a Culture of Dependence from Didactic Teaching" – ISI indexed WSEAS Jakarta Conference proceedings 2011
  (added 40% new content and submitted to WSEAS for scopus journal review 17.1.12)
  R DIN, MF KAMARULZAMAN, VERAWATI, N.A. JOHAR, I.F. KHAMSIN, A.A. KARIM

- Article 23/36 (on 26.1.12) Restructuring of the E-Learning Styles Factors for Technology Training – ISI indexed journal WASJ 2011

  Rosseni Din, M Faisal Kamarulzaman, Parilah M Shah, Saemah Rahman, Aidah A Karim, Rahilah Omar, Maimun Aqsha Lubis, M Sahari Nordin, M Shanudin Zakaria, Khairul Anwar Mastor

# Phase 1 Preparation: 31 Jan 2012 WS

- Identify the questions to be answered and the construct to be analyze and report
- Come up with a title
- Decide who will co-write with you, the more the merrier but everyone has to contribute something
- Authorship Definition

# Author Definition

- "authors are defined as individuals who gave intellectual  contribution, not financial, moral, or logistic contribution etc..."

Intellectual contributions among others are:

-Original structured idea (not a simplistic, general idea)

-Theoretical development

-Data collection design (simulation, experiment, survey etc.)

-Results analysis and interpretations

-Analysis and critical review/evaluation of previous studies

-Drafting, revising, and reviewing the manuscript

- Direct responsibility for and leadership of the performance of the study

# Title of the paper

- About 12-15 words
- State at least two:
  - Key concept
  - Population
  - Sub-set of population
  - Manipulated variable
  - Responding variable
  - Method
- Examples:
  - *Crossing Borders: Learning and teaching with technology in the pre-service to in-service transition*
  - *Student perceptions of Ubiquitous Learning Environments, Student-Teacher Interactions and Attitudes in Second Year Education Classes in a Public University in Malaysia*
  - *Training with Technology becoming Professionals through Participatory Design Method*

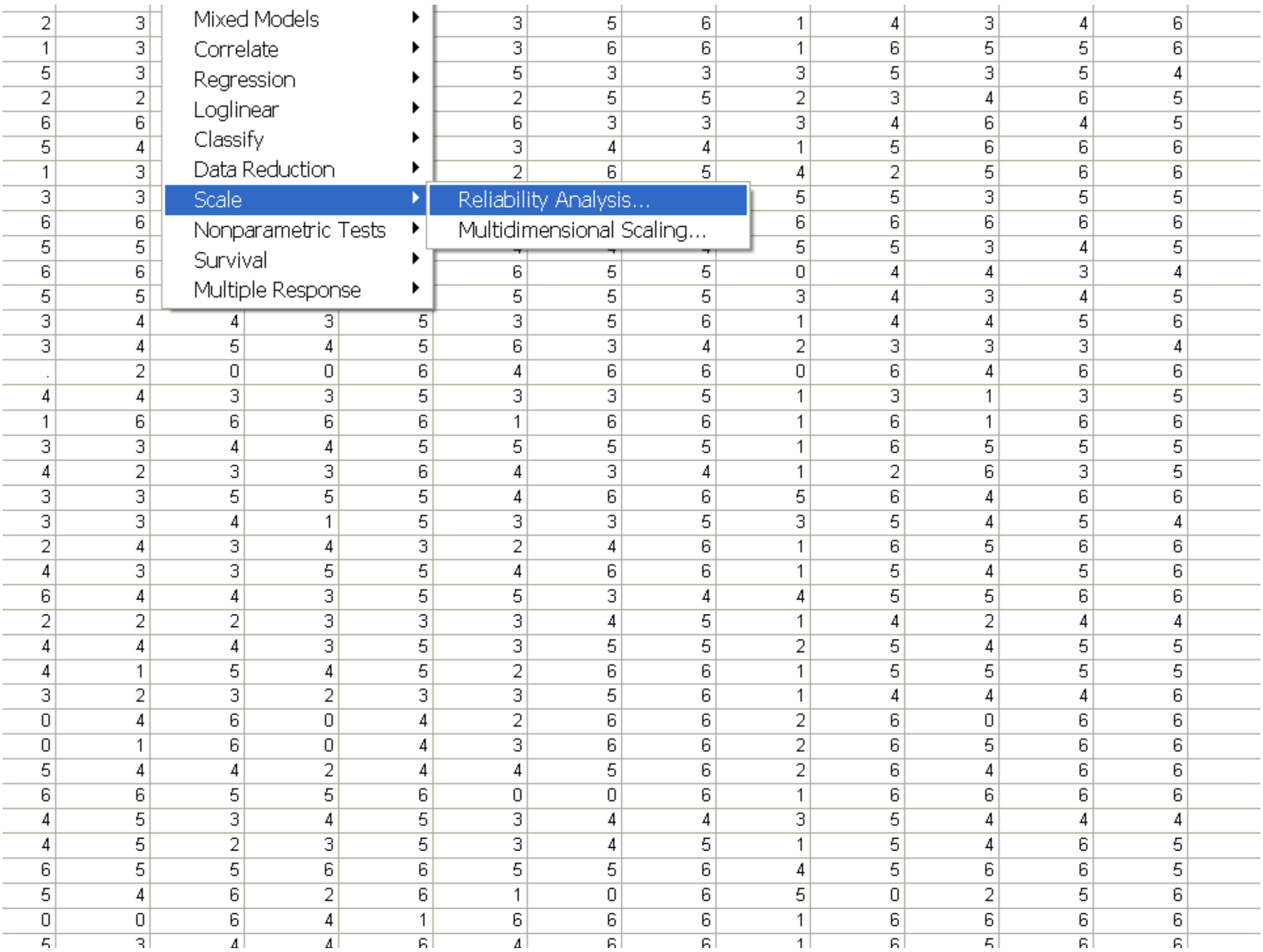
# An approach to PCA

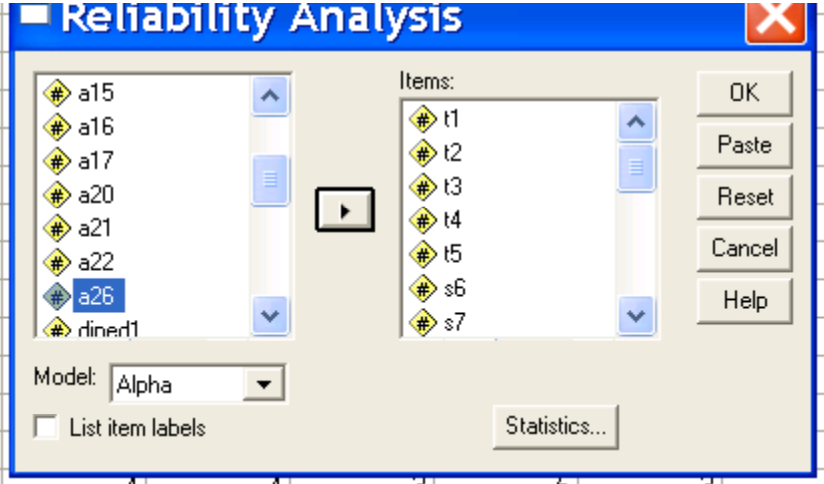
1. Develop a measurement model theoretically
2. Construct research questions
3. Construct instrument
4. Select sample → collect data
5. Run item analysis
6. Run PCA
7. Evaluate the model fit
8. Run validation analysis
9. Present the results

# S4: Select sample

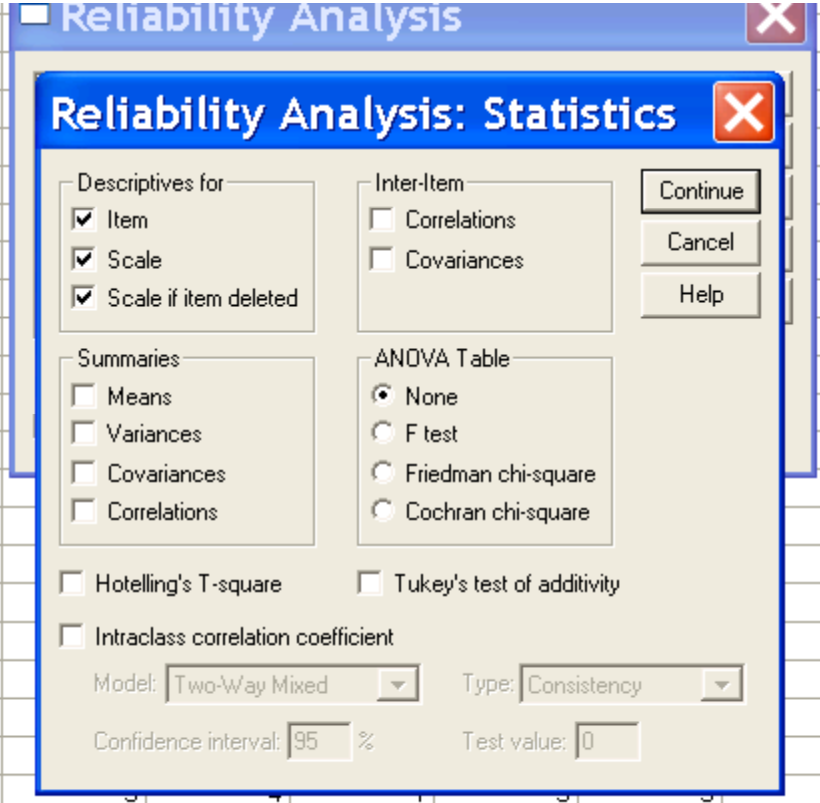
- define population
- random sample
- adequate sample
  - minimum:  5 respondents per item
  - maximum:  15 respondents per item
- a sample for cross-validation

# S5: Item Analysis


Mixed Models
Correlate
Regression
Loglinear
Classify
Data Reduction
Scale
Nonparametric Tests
Survival
Multiple Response
Reliability Analysis...
Multidimensional Scaling...



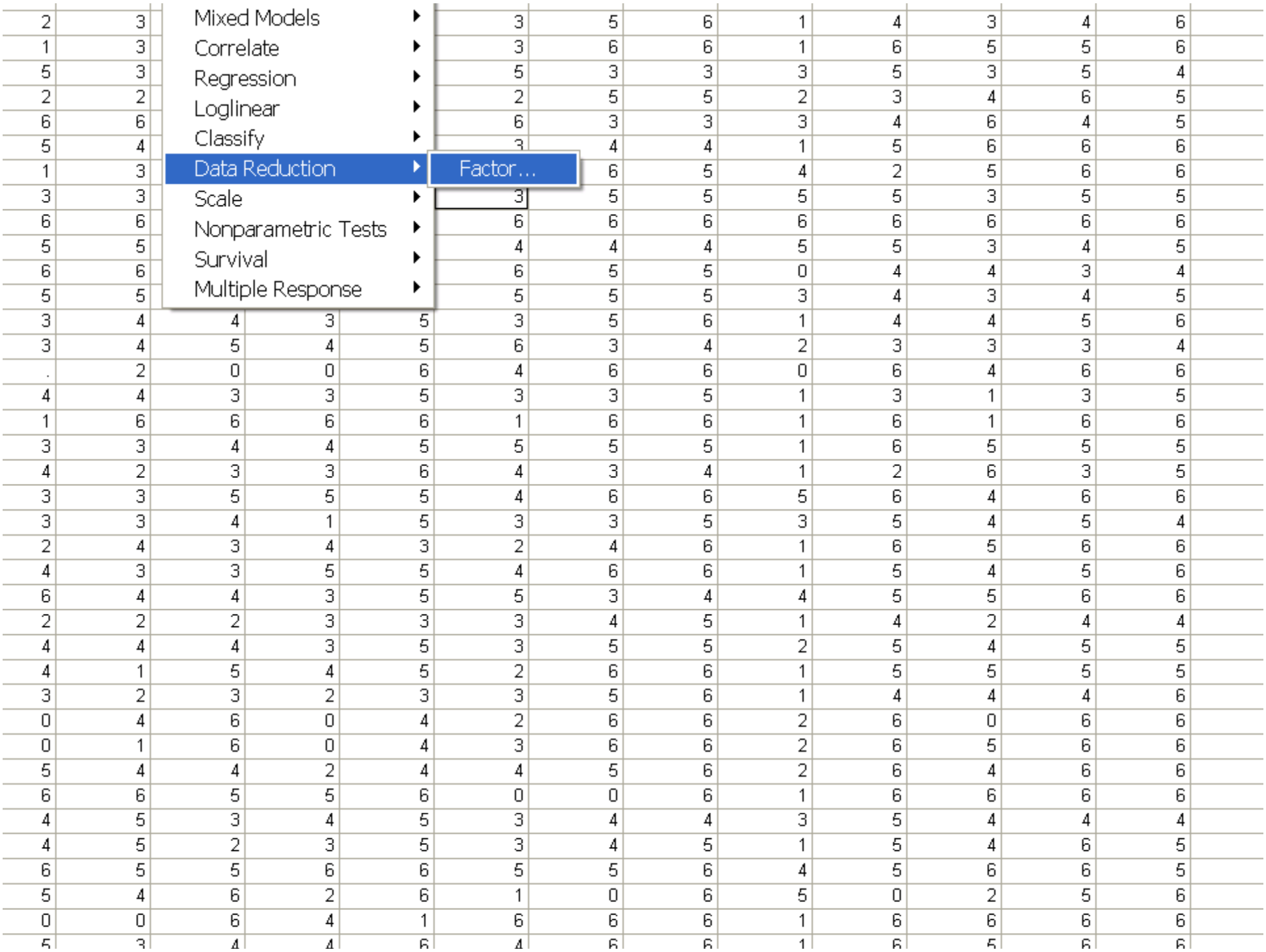

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | | | | | | 5 | 6 | 1 | 4 | 3 | 4 | 6 | |
| 1 | | | | | | 6 | 6 | 1 | 6 | 5 | 5 | 6 | |
| 5 | | | | | | 3 | 3 | 3 | 5 | 3 | 5 | 4 | |
| 2 | | | | | | 5 | 5 | 2 | 3 | 4 | 6 | 5 | |
| 6 | | | | | | 3 | 3 | 3 | 4 | 6 | 4 | 5 | |
| 5 | | | | | | 4 | 4 | 1 | 5 | 6 | 6 | 6 | |
| 1 | | | | | | 6 | 5 | 4 | 2 | 5 | 6 | 6 | |
| 3 | | | | | | 5 | 5 | 5 | 5 | 3 | 5 | 5 | |
| 6 | | | | | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | |
| 5 | | | | | | 4 | 4 | 5 | 5 | 3 | 4 | 5 | |
| 6 | | | | | | 5 | 5 | 0 | 4 | 4 | 3 | 4 | |
| 5 | | | | | | 5 | 5 | 3 | 4 | 3 | 4 | 5 | |
| 3 | 4 | 4 | 3 | 5 | 3 | 5 | 6 | 1 | 4 | 4 | 5 | 6 | |
| 3 | 4 | 5 | 4 | 5 | 6 | 3 | 4 | 2 | 3 | 3 | 3 | 4 | |
| . | 2 | 0 | 0 | 6 | 4 | 6 | 6 | 0 | 6 | 4 | 6 | 6 | |
| 4 | 4 | 3 | 3 | 5 | 3 | 3 | 5 | 1 | 3 | 1 | 3 | 5 | |
| 1 | 6 | 6 | 6 | 6 | 1 | 6 | 6 | 1 | 6 | 1 | 6 | 6 | |
| 3 | 3 | 4 | 4 | 5 | 5 | 5 | 5 | 1 | 6 | 5 | 5 | 5 | |
| 4 | 2 | 3 | 3 | 6 | 4 | 3 | 4 | 1 | 2 | 6 | 3 | 5 | |
| 3 | 3 | 5 | 5 | 5 | 4 | 6 | 6 | 5 | 6 | 4 | 6 | 6 | |
| 3 | 3 | 4 | 1 | 5 | 3 | 3 | 5 | 3 | 5 | 4 | 5 | 4 | |
| 2 | 4 | 3 | 4 | 3 | 2 | 4 | 6 | 1 | 6 | 5 | 6 | 6 | |
| 4 | 3 | 3 | 5 | 5 | 4 | 6 | 6 | 1 | 5 | 4 | 5 | 6 | |
| 6 | 4 | 4 | 3 | 5 | 5 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | |
| 2 | 2 | 2 | 3 | 3 | 3 | 4 | 5 | 1 | 4 | 2 | 4 | 4 | |
| 4 | 4 | 4 | 3 | 5 | 3 | 5 | 5 | 2 | 5 | 4 | 5 | 5 | |
| 4 | 1 | 5 | 4 | 5 | 2 | 6 | 6 | 1 | 5 | 5 | 5 | 5 | |
| 3 | 2 | 3 | 2 | 3 | 3 | 5 | 6 | 1 | 4 | 4 | 4 | 6 | |
| 0 | 4 | 6 | 0 | 4 | 2 | 6 | 6 | 2 | 6 | 0 | 6 | 6 | |
| 0 | 1 | 6 | 0 | 4 | 3 | 6 | 6 | 2 | 6 | 5 | 6 | 6 | |
| 5 | 4 | 4 | 2 | 4 | 4 | 5 | 6 | 2 | 6 | 4 | 6 | 6 | |
| 6 | 6 | 5 | 5 | 6 | 0 | 0 | 6 | 1 | 6 | 6 | 6 | 6 | |
| 4 | 5 | 3 | 4 | 5 | 3 | 4 | 4 | 3 | 5 | 4 | 4 | 4 | |
| 4 | 5 | 2 | 3 | 5 | 3 | 4 | 5 | 1 | 5 | 4 | 6 | 5 | |
| 6 | 5 | 5 | 6 | 6 | 5 | 5 | 6 | 4 | 5 | 6 | 6 | 5 | |
| 5 | 4 | 6 | 2 | 6 | 1 | 0 | 6 | 5 | 0 | 2 | 5 | 6 | |
| 0 | 0 | 6 | 4 | 1 | 6 | 6 | 6 | 1 | 6 | 6 | 6 | 6 | |
| 5 | 3 | 4 | 4 | 6 | 4 | 6 | 6 | 1 | 6 | 5 | 6 | 6 | |

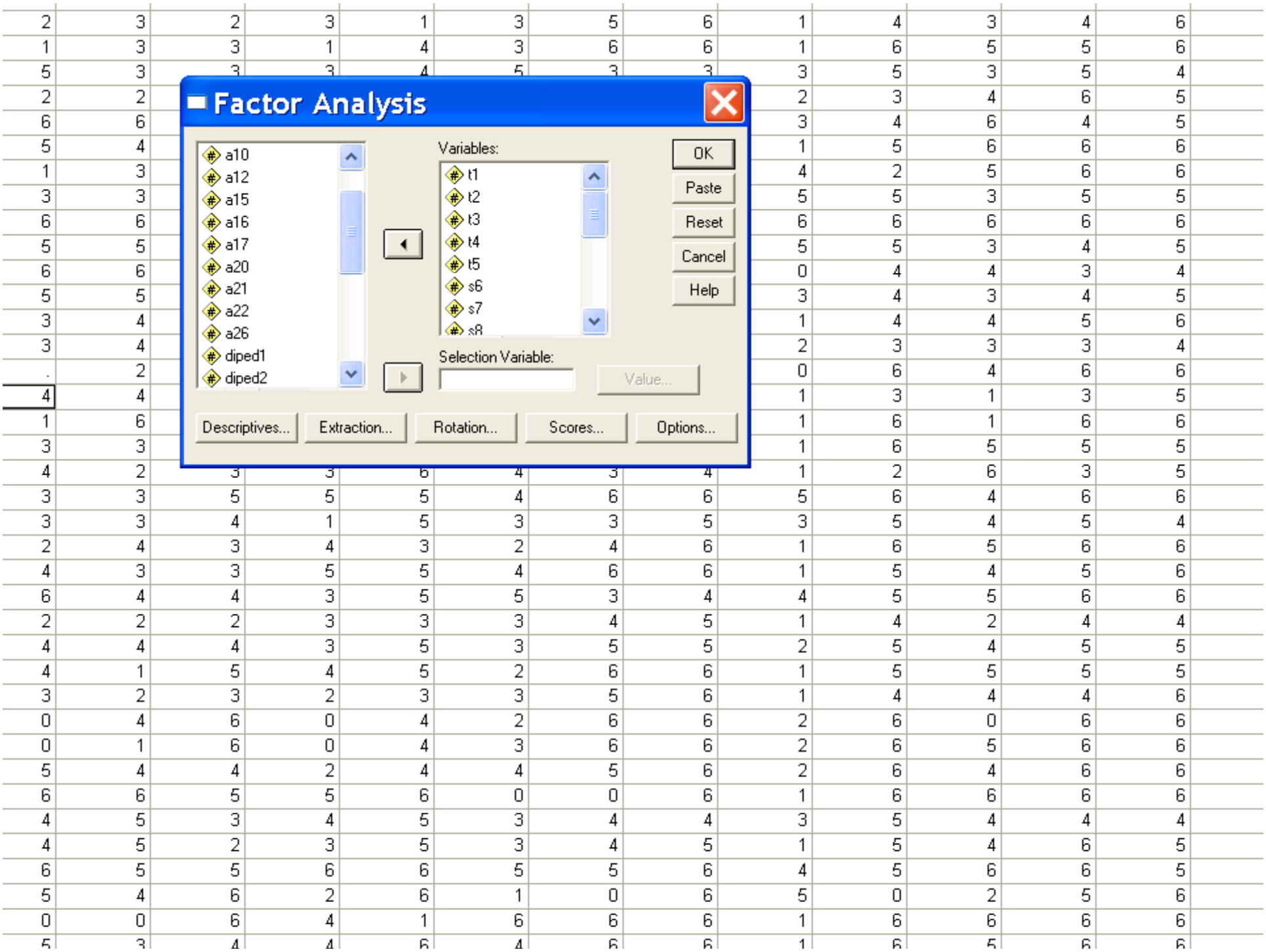

Reliability Analysis
Reliability Analysis: Statistics
Descriptives for
Item
Scale
Scale if item deleted
Inter-Item
Correlations
Covariances
Continue
Cancel
Help
Summaries
Means
Variances
Covariances
Correlations
ANOVA Table
None
F test
Friedman chi-square
Cochran chi-square
Hotelling's T-square
Tukey's test of additivity
Intraclass correlation coefficient
Model: Two-Way Mixed
Type: Consistency
Confidence interval: 95 %
Test value: 0

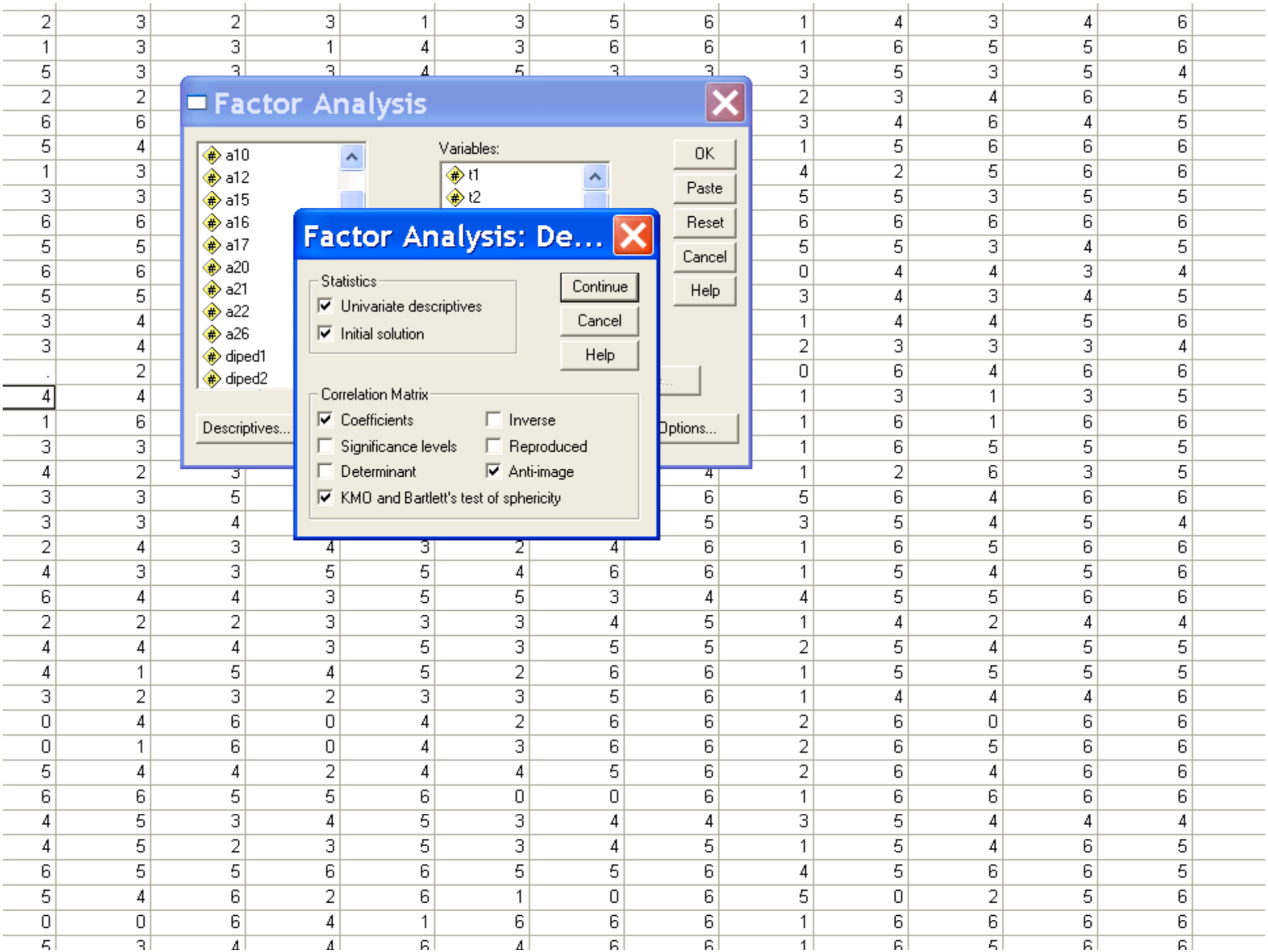
## Focus on the following stats

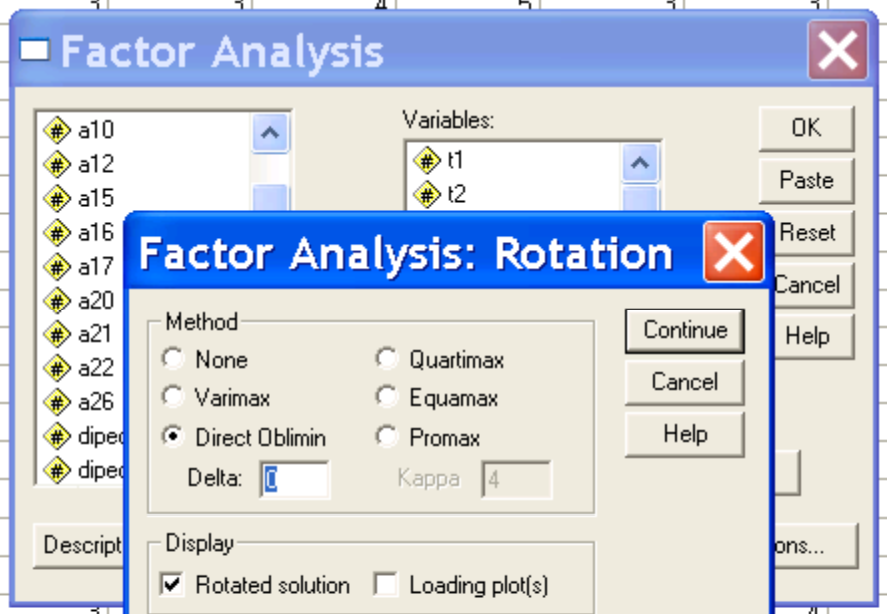
- Std deviation: examine items with very low SD (SD < .1)
- Alpha if item deleted
- Overall reliability index
- Sub-construct reliability index

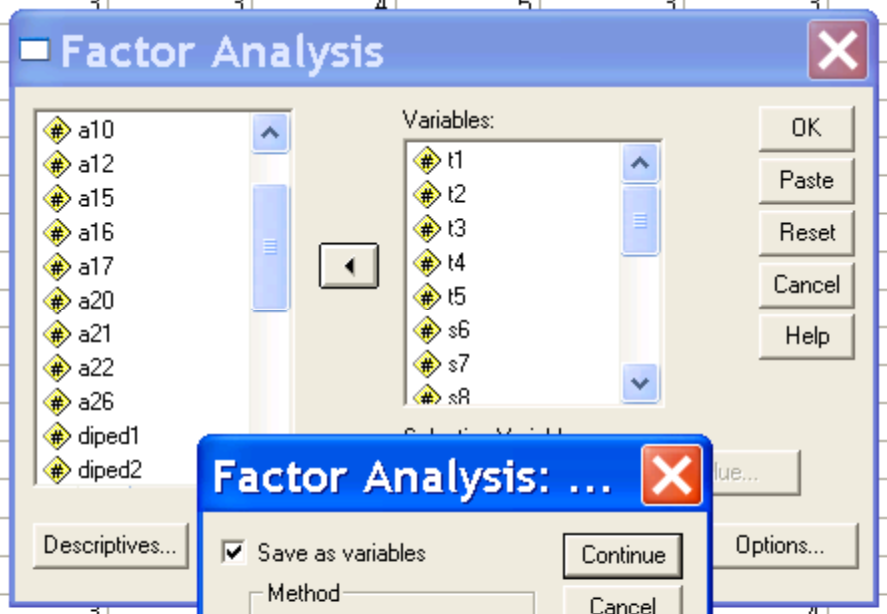
# S6: Run PCA


Mixed Models
Correlate
Regression
Loglinear
Classify
Data Reduction
Scale
Nonparametric Tests
Survival
Multiple Response
Factor...


Factor Analysis
a10
a12
a15
a16
a17
a20
a21
a22
a26
diped1
diped2
Variables:
t1
t2
t3
t4
t5
s6
s7
s8
Selection Variable:
Value...
OK
Paste
Reset
Cancel
Help
Descriptives...
Extraction...
Rotation...
Scores...
Options...

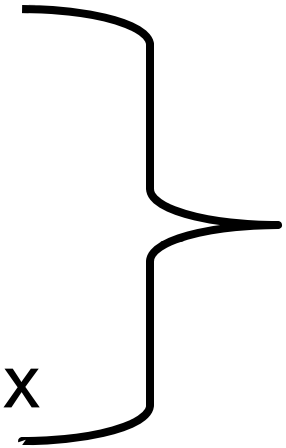

Factor Analysis
a10
a12
a15
a16
a17
a20
a21
a22
a26
diped1
diped2
Variables:
t1
t2
OK
Paste
Reset
Cancel
Help
Descriptives...
Options...
Factor Analysis: De...
Statistics
Univariate descriptives
Initial solution
Continue
Cancel
Help
Correlation Matrix
Coefficients
Inverse
Significance levels
Reproduced
Determinant
Anti-image
KMO and Bartlett's test of sphericity


Factor Analysis
a10
a12
a15
a16
a17
a20
a21
a22
a26
Variables:
t1
t2
OK
Paste
Reset
Cancel
Help
Descript
ons...
Factor Analysis: Rotation
Method
None
Varimax
Direct Oblimin
Delta:
Quartimax
Equamax
Promax
Kappa
4
Continue
Cancel
Help
Display
Rotated solution
Loading plot(s)
Maximum Iterations for Convergence:
25


Factor Analysis
a10
a12
a15
a16
a17
a20
a21
a22
a26
diped1
diped2
Variables:
t1
t2
t3
t4
t5
s6
s7
s8
OK
Paste
Reset
Cancel
Help
Descriptives...
Options...
Factor Analysis: ...
Save as variables
Method
Regression
Bartlett
Anderson-Rubin
Continue
Cancel
Help
Display factor score coefficient matrix

## Check the following tables

1. Correlation Matrix
2. KMO, Bartlett's Test
3. Anti-image matrix
4. Communalities matrix
5. PVE
6. Pattern Matrix



# An approach to PCA

1. Develop a measurement model theoretically
2. Construct research questions
3. Construct instrument
4. Select sample → collect data
5. Run item analysis
6. Run PCA
7. Evaluate model fit
8. Run cross-validation
9. Present the results

# Evaluate model fit

1. Assessment of assumption
2. Number of extracted factors (components)
3. Proportion of variance explained
4. Number of items for each factor
5. Direction and magnitude of factor loading
6. Noises & contamination?
7. Interpretability of each factor
8. Reliability index for each factor

# 1. Assessment of assumption: correlated items

- Bartlett test of sphericity
- Overall measure of sampling adequacy (MSA)
- Individual item MSA

MSA

## KMO and Bartlett's Test

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Samplin Adequacy. | | .788 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 1213.997 |
| | df | 105 |
| | Sig. | .000 |

**Anti-image Matrices**

| | | T1 | T2 | T3 | T4 | T5 | S6 | S7 | S8 | S9 | S10 | ST11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | .449 | -.224 | -6.01E-02 | -5.18E-03 | -.136 | 1.933E-02 | 2.833E-02 | 3.236E-02 | 3.438E-02 | -4.73E-02 | -3.53E-02 | 3 |
| | T2 | -.224 | .420 | -.131 | -4.13E-02 | -4.99E-02 | 4.178E-02 | -2.07E-02 | -5.36E-02 | 6.041E-02 | 1.882E-02 | -2.12E-02 | 1 |
| | T3 | -6.01E-02 | -.131 | .550 | -.228 | -1.94E-02 | -4.76E-03 | -4.26E-03 | 2.896E-02 | 3.587E-03 | 2.543E-02 | 6.755E-02 | - |
| | T4 | -5.18E-03 | -4.13E-02 | -.228 | .617 | -8.74E-02 | -1.70E-02 | 3.723E-02 | -.112 | -2.14E-02 | -1.09E-02 | -.137 | 1 |
| | T5 | -.136 | -4.99E-02 | -1.94E-02 | -8.74E-02 | .690 | 7.409E-02 | -3.45E-02 | 7.154E-02 | -7.17E-03 | -3.44E-02 | .102 | - |
| | S6 | 1.933E-02 | 4.178E-02 | -4.76E-03 | -1.70E-02 | 7.409E-02 | .610 | -.169 | -.101 | 7.217E-03 | -9.58E-02 | -4.32E-03 | 5 |
| | S7 | 2.833E-02 | -2.07E-02 | -4.26E-03 | 3.723E-02 | -3.45E-02 | -.169 | .515 | -6.20E-02 | -2.47E-02 | -.205 | -5.37E-02 | 5 |
| | S8 | 3.236E-02 | -5.36E-02 | 2.896E-02 | -.112 | 7.154E-02 | -.101 | -6.20E-02 | .732 | -7.21E-02 | -7.52E-02 | 1.916E-02 | 5 |
| | S9 | 3.438E-02 | 6.041E-02 | 3.587E-03 | -2.14E-02 | -7.17E-03 | 7.217E-03 | -2.47E-02 | -7.21E-02 | .655 | -.185 | 7.223E-03 | - |
| | S10 | -4.73E-02 | 1.882E-02 | 2.543E-02 | -1.09E-02 | -3.44E-02 | -9.58E-02 | -.205 | -7.52E-02 | -.185 | .446 | 2.381E-02 | - |
| | ST11 | -3.53E-02 | -2.12E-02 | 6.755E-02 | -.137 | .102 | -4.32E-03 | -5.37E-02 | 1.916E-02 | 7.223E-03 | 2.381E-02 | .378 | |
| | ST12 | 3.121E-02 | 1.700E-02 | -2.11E-02 | 1.556E-02 | -9.62E-02 | 5.815E-03 | 5.193E-02 | 5.093E-02 | -5.44E-02 | -3.01E-02 | -.193 | |
| | ST13 | 1.060E-02 | 9.198E-03 | -4.64E-02 | 4.845E-03 | 6.345E-02 | 1.884E-02 | 1.681E-02 | -5.05E-02 | -1.49E-02 | -4.65E-02 | -7.00E-03 | - |
| | ST14 | -2.49E-02 | 9.754E-03 | -2.99E-02 | 6.031E-02 | -2.06E-02 | -2.93E-02 | -8.98E-03 | -4.68E-03 | 2.586E-02 | -1.17E-02 | -7.19E-02 | - |
| | ST15 | [illegible] | [illegible] | -2.13E-02 | 9.329E-02 | -9.03E-02 | -2.31E-02 | 6.509E-02 | -2.99E-02 | -3.07E-02 | 7.287E-03 | -.116 | 5 |
| Anti-image Correlation | T1 | .753[a] | -.517 | [illegible] | -9.83E-03 | -.245 | 3.694E-02 | 5.893E-02 | 5.644E-02 | 6.341E-02 | -.106 | -8.58E-02 | 7 |
| | T2 | -.517 | .763[a] | -.274 | [illegible] | -9.27E-02 | 8.257E-02 | -4.45E-02 | -9.67E-02 | .115 | 4.351E-02 | -5.32E-02 | 3 |
| | T3 | -.121 | -.274 | .773[a] | -.391 | [illegible] | -8.21E-03 | -8.00E-03 | 4.562E-02 | 5.976E-03 | 5.134E-02 | .148 | - |
| | T4 | -9.83E-03 | -8.12E-02 | -.391 | .654[a] | -.134 | [illegible] | 6.604E-02 | -.166 | -3.36E-02 | -2.09E-02 | -.284 | 2 |
| | T5 | -.245 | -9.27E-02 | -3.15E-02 | -.134 | .729[a] | .114 | [illegible] | .101 | -1.07E-02 | -6.20E-02 | .200 | |
| | S6 | 3.694E-02 | 8.257E-02 | -8.21E-03 | -2.77E-02 | .114 | .850[a] | -.302 | -.151 | 1.142E-02 | -.184 | -9.01E-03 | 1 |
| | S7 | 5.893E-02 | -4.45E-02 | -8.00E-03 | 6.604E-02 | -5.79E-02 | -.302 | .739[a] | -.101 | [illegible] | -.427 | -.122 | |
| | S8 | 5.644E-02 | -9.67E-02 | 4.562E-02 | -.166 | .101 | -.151 | -.101 | .822[a] | -.104 | -.132 | 3.643E-02 | 8 |
| | S9 | 6.341E-02 | .115 | 5.976E-03 | -3.36E-02 | -1.07E-02 | 1.142E-02 | -4.25E-02 | -.104 | .845[a] | [illegible] | 1.452E-02 | |
| | S10 | -.106 | 4.351E-02 | 5.134E-02 | -2.09E-02 | -6.20E-02 | -.184 | -.427 | [illegible] | -.342 | .770[a] | 5.802E-02 | - |
| | ST11 | -8.58E-02 | -5.32E-02 | .148 | -.284 | .200 | -9.01E-03 | -.122 | 3.643E-02 | 1.452E-02 | 5.802E-02 | .756[a] | |
| | ST12 | 7.022E-02 | 3.956E-02 | -4.28E-02 | 2.985E-02 | -.175 | 1.122E-02 | .109 | 8.969E-02 | -.101 | [illegible] | -.474 | |
| | ST13 | 2.544E-02 | 2.283E-02 | -.101 | 9.916E-03 | .123 | 3.879E-02 | 3.766E-02 | -9.49E-02 | -2.96E-02 | -.112 | -1.83E-02 | |
| | ST14 | -6.17E-02 | 2.500E-02 | -6.69E-02 | .127 | -4.12E-02 | -6.22E-02 | -2.08E-02 | -9.07E-03 | 5.305E-02 | -2.92E-02 | -.194 | |
| | ST15 | 6.237E-02 | -1.75E-02 | -4.44E-02 | .184 | -.168 | -4.58E-02 | .141 | -5.41E-02 | -5.87E-02 | 1.691E-02 | -.293 | |

MSA

a. Measures of Sampling Adequacy(MSA)

## 2. Number of factors extracted

- *A priori* criterion
- Eigenvalue for each component ≥ 1.00
- Scree test/plot criterion

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation |
|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| 1 | 3.907 | 26.047 | 26.047 | 3.907 | 26.047 | 26.047 | 3.598 |
| 2 | 3.109 | 20.723 | 46.770 | 3.109 | 20.723 | 46.770 | 2.915 |
| 3 | 2.069 | 13.791 | 60.561 | 2.069 | 13.791 | 60.561 | 2.979 |
| 4 | .921 | 6.140 | 66.701 | | | | |
| 5 | .806 | 5.373 | 72.074 | | | | |
| 6 | .727 | 4.849 | 76.923 | | | | |
| 7 | .588 | 3.918 | 80.841 | | | | |
| 8 | .574 | 3.826 | 84.667 | | | | |
| 9 | .451 | 3.006 | 87.673 | | | | |
| 10 | .422 | 2.814 | 90.487 | | | | |
| 11 | .366 | 2.439 | 92.926 | | | | |
| 12 | .301 | 2.007 | 94.933 | | | | |
| 13 | .286 | 1.906 | 96.839 | | | | |
| 14 | .262 | 1.745 | 98.584 | | | | |
| 15 | .212 | 1.416 | 100.000 | | | | |

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total varia

3. Proportion of variance explained

± 60% PVE, higher % better!

**Variance Explained?**

# Evaluate model fit

1. Assessment of assumption
2. Number of extracted factors (components)
3. Proportion of variance explained
4. Number of items for each factor
5. Direction and magnitude of factor loading
6. Noises & contamination?
7. **Interpretability of each factor**
8. Reliability index for each factor

# *Reporting a PCA study: Introduction*

- Background of the Study
- Statement of Problem
- Objective of the Study
  - Research Questions and/or
  - Research Hypotheses
- Conceptual Framework

# *Reporting a PCA Study: Method*

- 3.1. Introduction
- 3.2. Population
- 3.3. Sample
  - 3.3.1. Characteristics
  - 3.3.2. Sample size
  - 3.3.3. Justification for sample size
- 3.4. Sampling Procedure
- 3.5. Instrument
  - 3.5.1. Background
  - 3.5.2. Validity & Reliability
- 3.6. Pilot Test
- 3.7. Other Research Procedures

# Reporting a PCA Study: Results

1. Assessment of assumption
2. Number of extracted components (rotation)
3. Proportion of variance explained
4. Number of items for each factor
5. Direction and magnitude of factor loading
6. Noises & contamination?
7. **Interpretation of each factor**
8. Reliability index of each factor